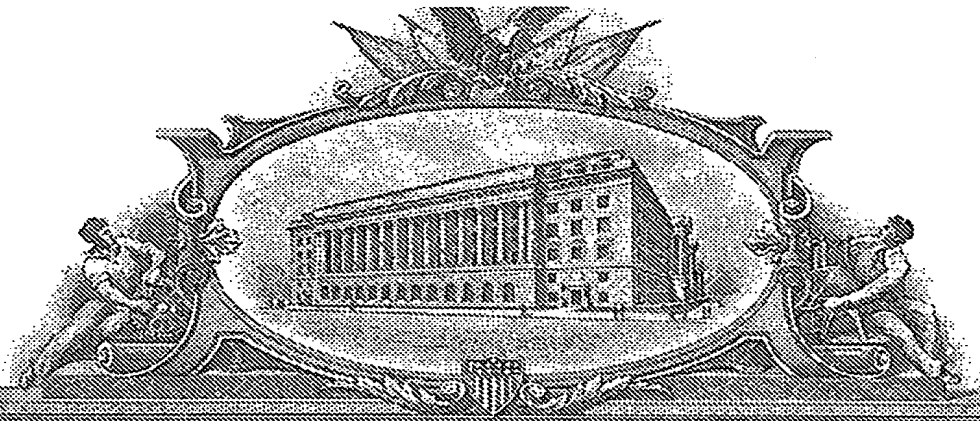


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**APPLICATION NUMBER: 60/353,530**

**FILING DATE: February 01, 2002**

**RELATED PCT APPLICATION NUMBER: PCT/US03/03323**

**THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US60/353,530**



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**PROVISIONAL APPLICATION FOR PATENT COVER SHEET**

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

**INVENTOR(S)**

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☐ Additional inventors are being named on the \_\_\_\_\_ separately numbered sheets attached hereto
**TITLE OF THE INVENTION (280 characters max)**

Mini-Mesa Avalanche Photodiodes

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**ENCLOSED APPLICATION PARTS (check all that apply)**

☒ Specification Number of Pages **2** ☐ CD(s), Number \_\_\_\_\_

☒ Drawing(s) Number of Sheets **3** ☐ Other (specify) \_\_\_\_\_

☐ Application Data Sheet. See 37 CFR 1.76

**METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)**

☒ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: **23-1925**

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: \_\_\_\_\_

Respectfully submitted,

SIGNATURE

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TELEPHONE

Date

**2/1/02**

REGISTRATION NO. **30,670**

(if appropriate)  
Docket Number: **10555-029**

**USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT**

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

P16SMALL/REV05

**CERTIFICATE OF MAILING BY "EXPRESS MAIL" (37 CFR 1.10)**Applicant(s): **Cheng et al.**

Docket No.

**10555-029**

Serial No.

Filing Date

Examiner

Group Art Unit

Invention: **Mini-Mesa Avalanche Photodiodes**I hereby certify that this **Provisional Application, Transmittal Letter, and Three Sheets of Drawings***(Identify type of correspondence)*

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20231-0001 on **February 1, 2002***(Date)***M. Collins***(Typed or Printed Name of Person Mailing Correspondence)**(Signature of Person Mailing Correspondence)***ET719098310US***("Express Mail" Mailing Label Number)***Note: Each paper must have its own certificate of mailing.**

## MINI-MESA AVALANCHE PHOTODIODES

In an embodiment of the present invention, a way of achieving a localized p-contact region without using a p-diffusion is to etch a "mini-mesa". That is, the full structure is grown initially including the p<sup>+</sup> contact, and then it is etched down to the low doped InAlAs contact layer. This defines a small localized p- contact region which controls the relevant capacitance area, thus resulting in a low capacitance, and a high speed APD. We have performed initial experiments with this structure and as predicted it had low capacitance and a high speed response comparable to the regular standard full mesa APD (see Figure 1). The advantage of this structure is that it is completely epitaxially grown initially and does not require any p diffusion. It should have better passivation characteristics than the full mesa since the electric field at the edges of the low bandgap InGaAs is substantially reduced from that in the standard full mesa geometry. The structure can then be passivated with BCB as indicated below.

In a further embodiment of the present invention, a particularly advantageous approach to passivating this structure is to use wet oxidation of the AlInAs layers. The top p AlInAs layer can be oxidized down to the InGaAs or grading layer. At the same time the sides of the outer mesa can be oxidized to passivate it. It may be advantageous to oxidize the AlInAs so that there is a gradual interface between the unoxidized and oxidized AlInAs. This will reduce the field at this interface leading to better passivation. In addition, it may be advantageous to combine this approach with proton or oxygen

implantation to additionally control the p+ charge layer and reduce the field at the edge of the outer mesa to further improve passivation.

Figure 1

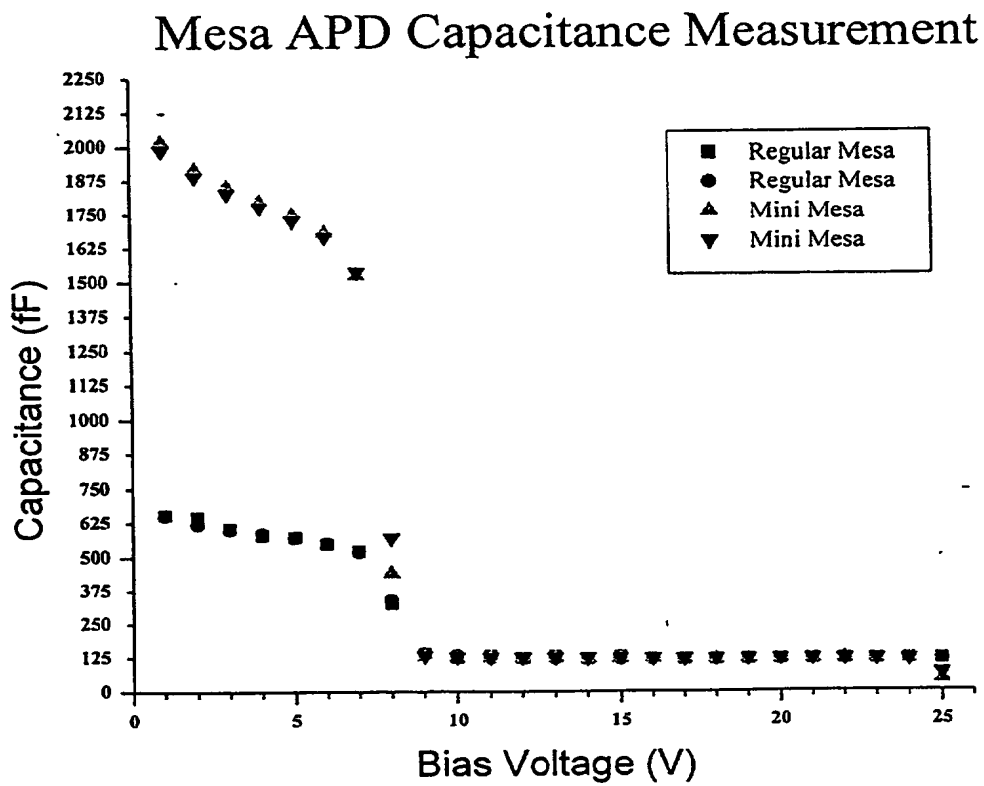
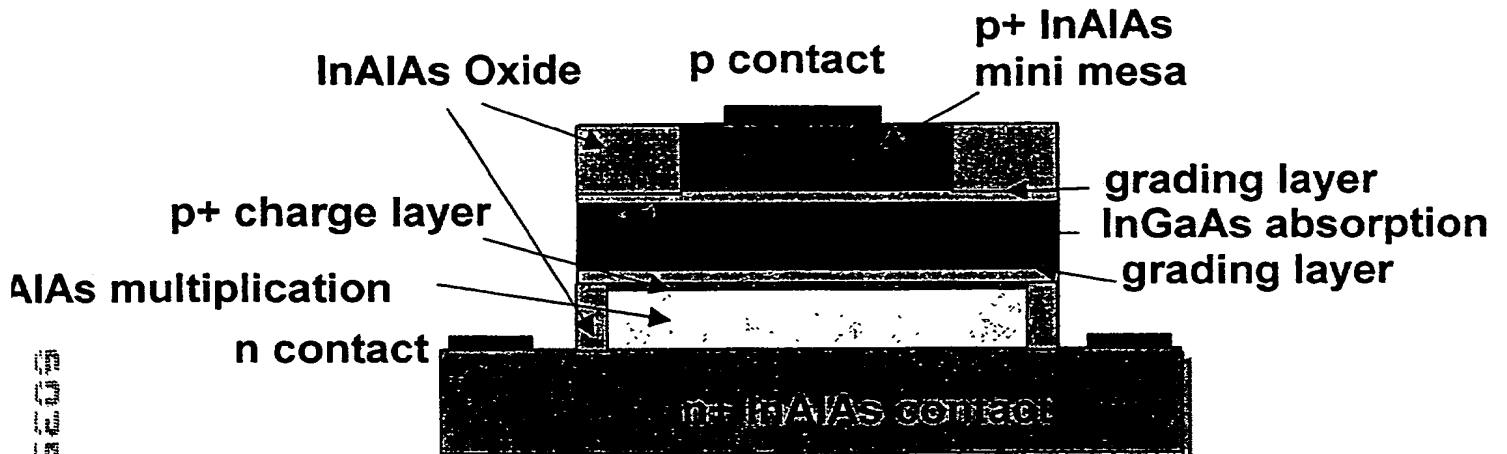


FIGURE 2

## Mini Mesa APD With oxidized InAlAs



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## Mini Mesa APD With BCB Passivation

FIGURE 3

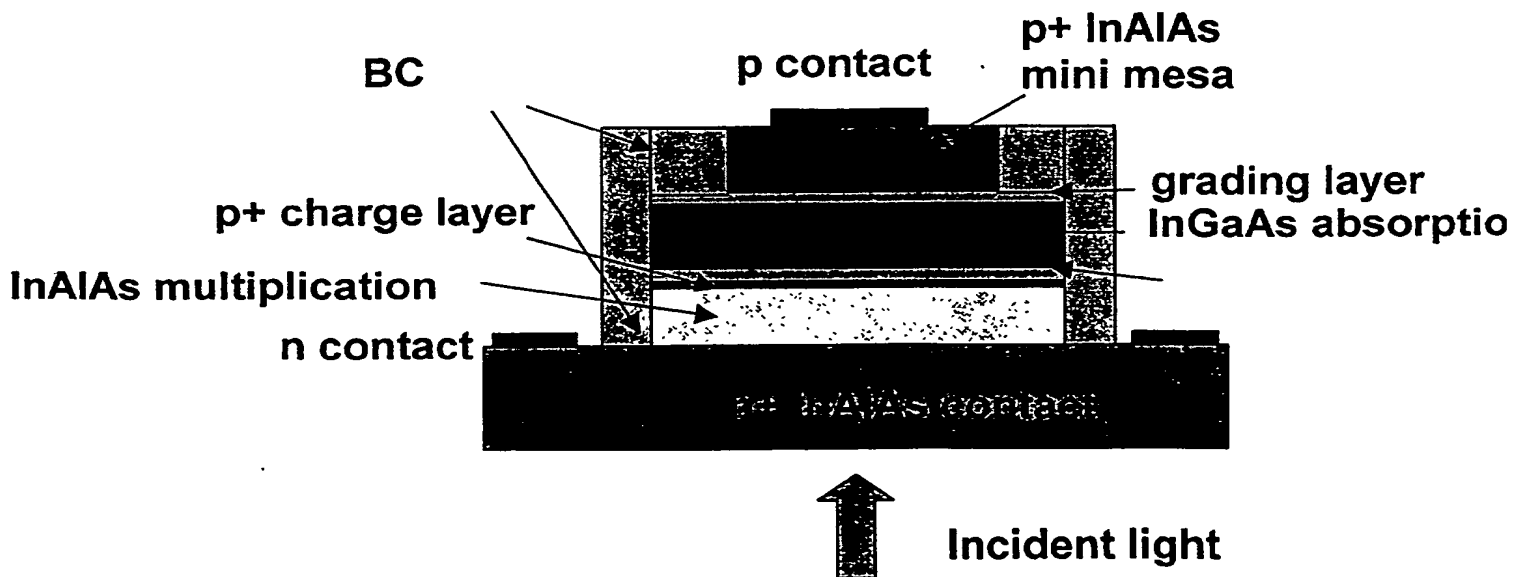
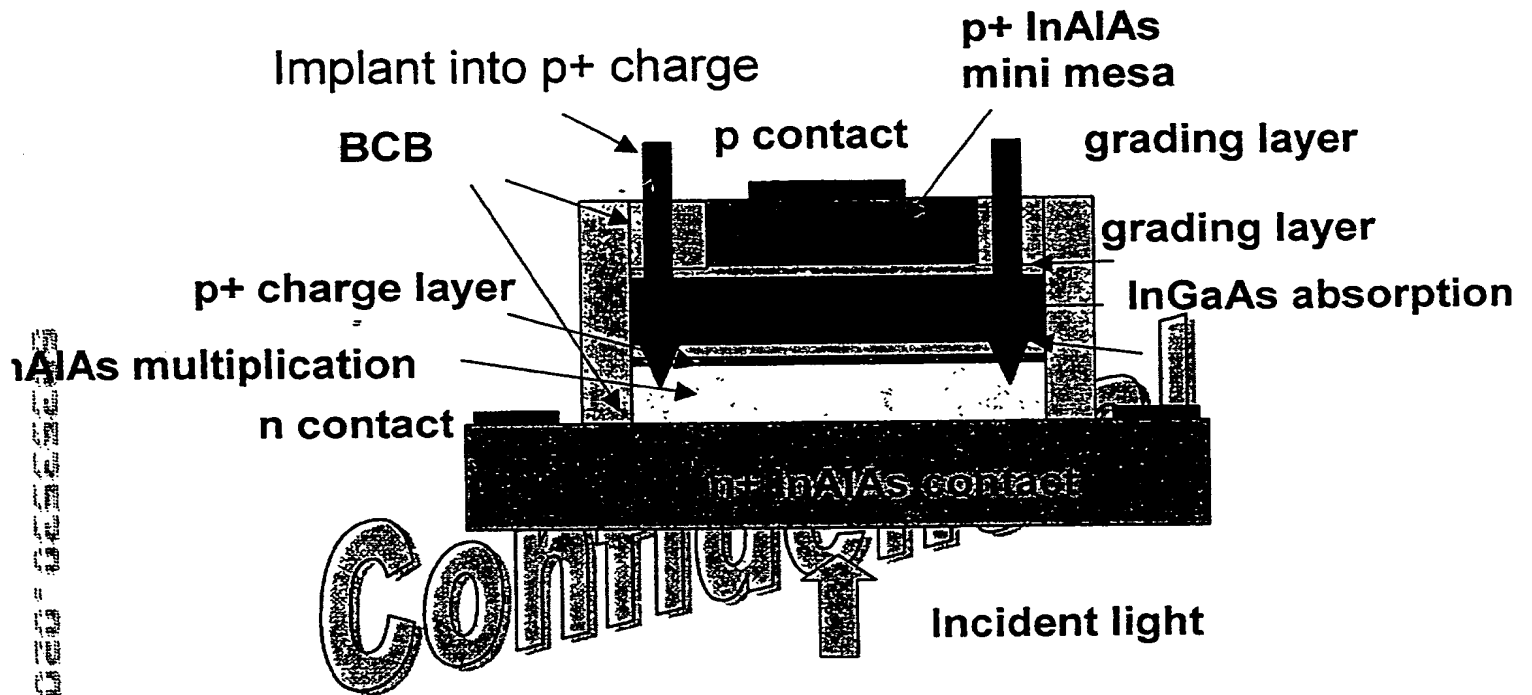


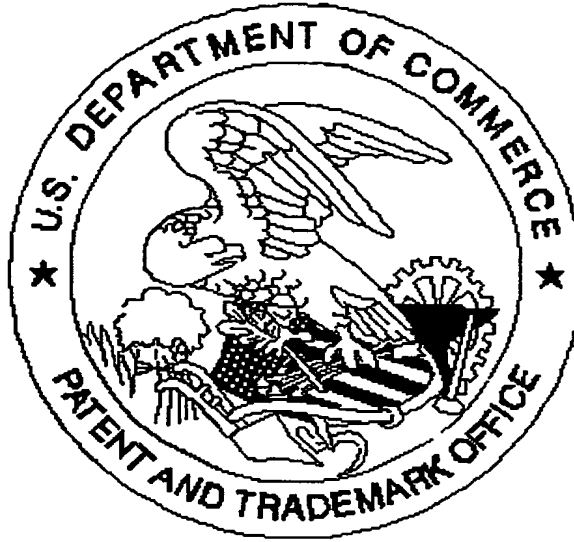
Figure 4

## Mini Mesa APD

With Implant into p+ charge layer  
Combined with Either BCB or Oxide Passivation  
(BCB shown)



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